6. Reliable Integrated Thermal Packaging for Power Electronics

Course Leader: Patrick McCluskey – University of Maryland

Course Objective:
Power electronics are becoming ubiquitous in engineered systems as they replace traditional ways to control the generation, distribution, and use of energy. They are used in products as diverse as home appliances, cell phone towers, aircraft, wind turbines, radar systems, smart grids, and data centers. This widespread incorporation has resulted in significant improvements in efficiency over previous technologies, but it also has made it essential that the reliability of power electronics be characterized and enhanced. Recently, increased power levels, made possible by new compound semiconductor materials, combined with increased packaging density have led to higher heat densities in power electronic systems, especially inside the switching module, making thermal management more critical to performance and reliability of power electronics.

This course will emphasize approaches to integrated thermal packaging that address performance limits and reliability concerns associated with increased power levels and power density. Following a quick review of active heat transfer techniques, along with prognostic health management, this short course will present the latest developments in the materials (e.g., organic, flexible), packaging, assembly, and thermal management of power electronic modules, MEMS, and systems and in the techniques for their reliability assessment.

Course Outline:

1. Motivation for Integrated Thermal Packaging for Reliable Power Electronic Systems and Heterogeneous Integration
2. Simulation and Assessment of Active Thermal Management Techniques: Air; Single Phase Liquid; Two Phase; Heat Pipes; and, Thermoelectric
3. Application of Thermal Management Techniques to Commercial Power Systems
4. Durability Assessment: Failure Modeling; Simulation; Testing; and Health Monitoring
5. Reliability and Thermal Packaging of Active Devices: Si; SiC; GaN; and Interconnects
6. Reliability and Thermal Packaging of Switching Modules, including organic encapsulants
7. Reliability in Rigid Assembly Packaging: PCBs; Solders; and Passives
8. Flexible Materials, Packaging, and Thermal Management: Flex circuit and OLED
9. Reliability of Additive Manufactured and Embedded Power Electronics

Who Should Attend:
This course is intended for engineers and managers who want to learn more about the thermal limitations and reliability concerns involved in the heterogeneous integration and packaging of power electronic devices and systems.

BIO:
Dr. Patrick McCluskey is a Professor of Mechanical Engineering at the University of Maryland, College Park and the Department's Design and Systems Reliability Division Leader. He has over 25 years of research experience in the areas of thermal management, reliability, and packaging of electronic systems for use in extreme temperature environments and power applications. Dr. McCluskey has published three books and over 150 peer-reviewed technical articles with over 3000 citations. He is an associate editor of the IEEE Transactions on Components, Packaging, and Manufacturing Technology, a member of the board of governors of the IEEE Electronic Packaging Society, a fellow and director of IMAPS and a member of ASME and AIAA.